THE MORPHOLOGY OF THE SALIVARY GLANDS OF TERRESTRIAL HETEROPTERA (GEOCORISAE) AND ITS BEARING ON CLASSIFICATION

BY

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Introduction

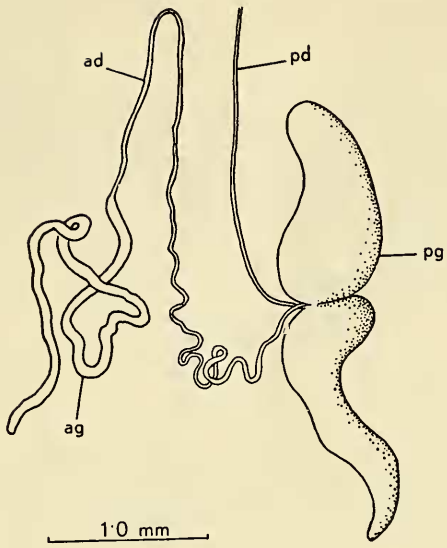
The salivary glands of several species of Heteroptera were figured by DUFOUR (1833) in his classical work; those of other terrestrial species are described by BREAKEY (1936), CORNWALL (1923), ELSON (1937), GOODCHILD (1952), HOOD (1937), KERSHAW (1911), LANDOIS (1868), MALOUF (1933), NUORTEVA (1954), PURI (1924), SAREL-WHITFIELD (1929), STROGAYA (1950), and WOOLLEY (1949). The only general works on salivary glands are those of BUGNION (1908, 1910) and BAPTIST (1940), whilst KÜNCKEL (1866) gives some notes on their functioning.

It appeared from a study of these papers that the form of the salivary glands is constant in related species and unlike that of the alimentary canal, it did not vary greatly with the feeding habits. If this hypothesis was correct salivary gland morphology would be of value in higher classification and further studies were undertaken to test it and to examine examples from families omitted by the above workers.

In the terrestrial Heteroptera there are two pairs of salivary glands: (1) the principal salivary glands situated on either side at the front of the thorax; (2) the accessory glands, one associated with each principal gland. The principal glands usually are bilobed, but they may be single or with three or four lobes. BAPTIST (1940) found no evidence to suggest that these lobes produced different chemical substances. From these glands the principal salivary duct runs anteriorly to join with the duct from the opposite side just before entering the salivary pump. Joining the principal gland close to the salivary duct is the duct of the accessory gland. These accessory glands, according to BAPTIST, "produce a watery secretion" and he showed that they are of two types, the tubular and the vesicular.

The tubular accessory gland is narrow and scarcely differentiated from its duct; the epithelial cells are cubical or columnar, their inner border strongly thickened. The vesicular accessory gland forms a distinct swelling at the end of the duct; the epithelial cells are flattened and polygonal, their inner border striated; these glands are generally closely adpressed to the anterior region of the mid gut.

From BAPTIST's (1940) work it appears that there is no relation between the type of secretion and the form of the glands. Further, it has been shown in *Eurygaster integriceps* Puton that the enzymes secreted vary during the life of the



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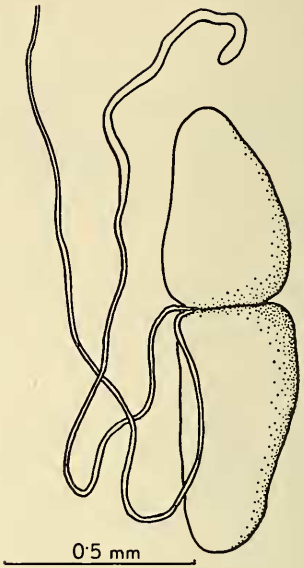

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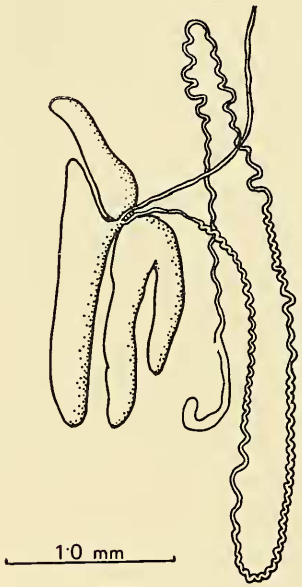

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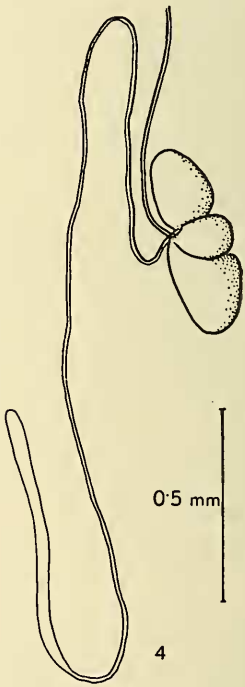

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Figs. 1—4. Salivary glands of Pentatomomorpha. 1. *Stollia fabricii* Kirk. (Pentatomidae). 2. *Aradus depressus* Fab. (Aradidae). 3. *Oncopeltus fasciatus* Dallas (Lygaeidae). 4. *Piesma quadrata* Fieb. (Piesmatidae). ad = accessory duct, ag = accessory gland, pd = principal duct, pg = principal gland.

individual this being correlated with a change in feeding habits (Kretovich, Bundel & Pshenova, 1943, and Nuorteva, 1954) that the saliva of the adult *Lygus rugulipennis* Poppius lacks the protease present in that of the larva.

Method

The figures in the present work are based on dissections of newly killed bugs carried out in 30% alcohol. Specimens preserved in 70% alcohol were occasionally used as supplementary material and in most cases the salivary glands were found to be in a satisfactory state of preservation.

The constancy of salivary gland structure in lower taxa

A few examples of the morphology of salivary glands are given below in order to show their constancy at different stages of a species, within genera and between related genera of varying feeding habits.

The salivary glands of a last instar larva of *Stenodema laevigatum* L. (fig. 17) are very similar to those of the adult (fig. 16), except for the shorter ducts. The salivary glands of adult *S. calcaratum* Fall. (fig. 18) also bear a strong likeness to those of *S. laevigatum*. Similarly the salivary glands of *Tingis ampliata* H.-S. (fig. 5) and *Nabis limbatus* Dahl. (fig. 7) resemble those figured by Baptist for *T. cardui* L. and *N. apterus* F. respectively.

Within the Miridae the salivary glands of the predatory *Deraeocoris lutescens* Sch. (fig. 10), are similar in general structure to those of partially predaceous (e.g. *Blephoridopterus angulatus* Fall., fig. 15) or entirely phytophagous (e.g. *Stenodema calcaratum*, fig. 18) species.

The descriptions and figures given by other workers, together with the glands examined by the writer, all support the view that these structures are reasonably constant at infra-familial levels.

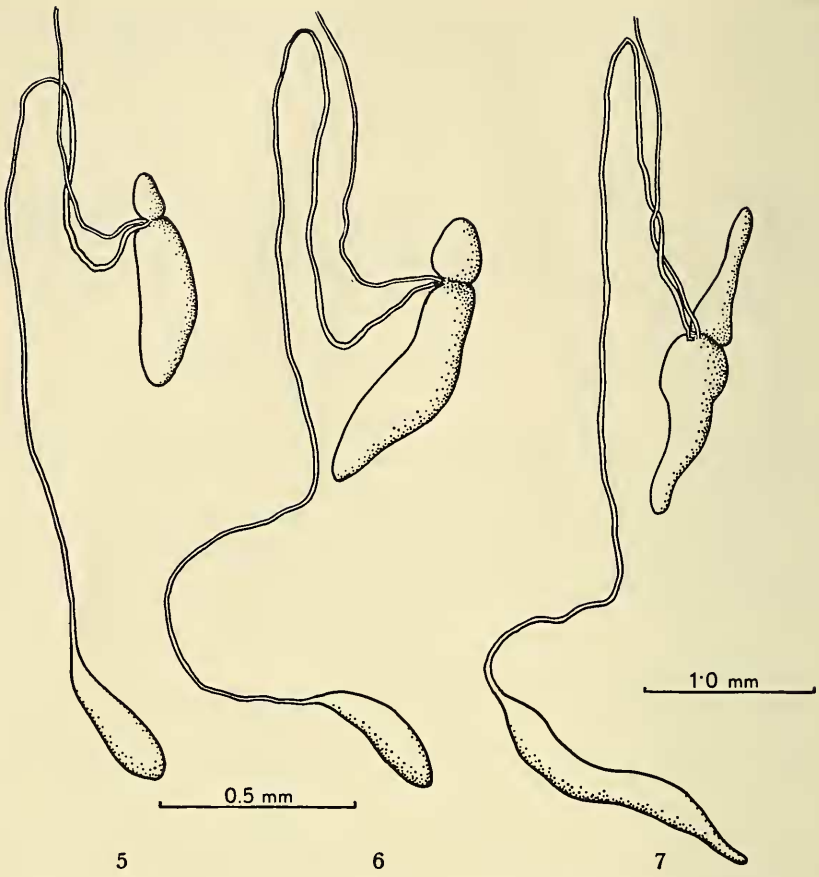
Salivary gland morphology in relation to higher taxa

On the basis of the two types of accessory salivary glands and other evidence two groups termed the Pentatomorpha and Cimicomorpha have been proposed (Leston et al., 1954). From the present work and that of other authors cited earlier, it seems possible to allot certain salivary gland characters to various taxonomic groups as follows.

1. Pentatomomorpha

Accessory salivary glands of the tubular type; ducts usually greatly convoluted or coiled.

Pentatomoidea: Principal gland with two lobes; the duct to the accessory gland is much coiled in the early part of its course, later becoming straight (fig. 1); the accessory gland itself often coiled. There is a suggestion that in this super-



Figs. 5—7. Salivary glands of Cimicomorpha. 5. *Tingis ampliata* H.-S. (Tingidae). 6. *Dictyonota strichnocera* Fieb. (Tingidae). 7. *Nabis limbatus* Dahl. (Nabidae).

family the types of principal salivary gland may correspond with family divisions; in many species the lower, or both, lobes of the principal gland are further subdivided into a few or many, more or less flabellate lobules (DUFOUR, 1833; BUGNION, 1908, 1910; SAREL-WHITFIELD, 1929).

Coreoidea: Principal gland with four lobes, these often subdivided; accessory duct slightly coiled; principal duct straight. There is insufficient evidence to determine whether salivary gland morphology supports the division of the superfamily into Coreidae, Rhopalidae and Alydidae. However, two members of the latter family (*Alydus calcaratus* and *Riptortus linearis*) figured by BUGNION (1910) have very similar four lobed principal salivary glands and the accessory duct with swelling midway along its length.

Pyrrhocoridae: Principal gland with four lobes; accessory duct coiled, principal duct convoluted. Only Pyrrhocorinae have been examined but the close similarity shown between the salivary glands of this subfamily and those of Coreoidea is

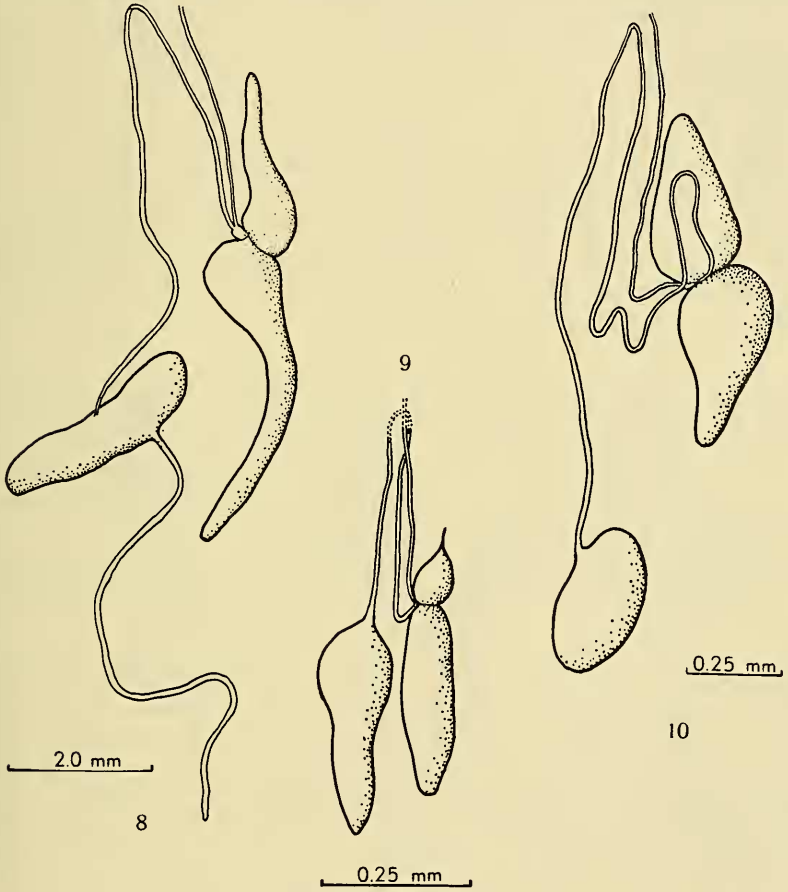
paralleled by Pruthi's (1925) findings in the male genitalia. Leston (1954) finds the female genitalia also support the view that Pyrrhocorinae are very closely allied to the Coreoidea and probably should be placed in that superfamily.

Lygaeoidea (Lygaeidae, Berytidae, Piesmatidae): Principal gland with three lobes, one of which may be partially subdivided; accessory duct convoluted in some species (fig. 3), most commonly only slightly coiled. The salivary glands of *Piesma maculata* Cost. are almost identical in form to those of *P. quadrata* Fieb. (fig. 4).

Aradoidea: Principal gland bilobed, ducts simple. The salivary glands of *Aneurus laevis* F. resemble in morphology those of *Aradus depressus* F. (fig. 2).

2. Cimicomorpha

Accessory salivary glands of vesicular type; ducts not greatly convoluted.



Figs. 8—10. Salivary glands of Cimicomorpha. 8. *Rhinocoris* sp. (Reduviidae). 9. *Microphysa elegantula* Baerensp. (Microphysidae). 10. *Deraeocoris lutescens* Sch. (Miridae, Deraeocorinae).

Reduviidae: Principal glands bilobed, but this division is almost lost in *Rhodnius prolixus* Stål. In this species the accessory duct ends blindly, but opens into the principal duct at its base. In *Triatoma infestans* Klug. (BAPTIST, 1940) the accessory gland is of the simple vesicular type; whilst in *Rhinocoris* sp. (fig. 8), *Reduvius personatus* L. (BUGNION, 1910) and *Pristhesancus papuensis* Stål (KERSHAW, 1911) a blind tubule arises from the accessory gland and runs posteriorly, adpressed to the mid gut. A similar condition is known in the aquatic *Belostoma flumineum* Say (ELSON, 1937). There is evidently some variation within the Reduviidae.

Tingidae: Principal glands bilobed, the anterior lobe much smaller than the posterior; the accessory duct is long (figs. 5 and 6). The salivary glands support the view that this family and the Piesmatidae are members of different major divisions.

Nabidae: Principal glands bilobed, the lobes sub-equal, the accessory gland long and tapered posteriorly (fig. 7).

Microphysidae: Principal glands bilobed; accessory gland large and slightly tapered (fig. 9).

Cimicidae: Principal glands consisting of a single lobe, accessory gland almost spherical.

Anthocoridae: Principal glands bilobed, accessory gland elongate.

Miridae: Principal glands generally bilobed, but in a cacao capsid (Bryocorinae) GOODCHILD (1952) found that they have four lobes. In all subfamilies, except the Bryocorinae (figs. 11 and 12), the accessory duct is looped over the anterior lobe of the principal gland (figs. 10 and 13—18). (The morphology of the salivary glands of the Cylapinae is unknown).

3. GEOCORISAE : *Incertae sedis*

Saldidae: BAPTIST (1940) figures the salivary glands of *Salda littoralis* L.; the principal glands are bilobed, the accessory glands are of the vesicular type and the ducts are almost straight. From the characters of the accessory glands this family shows affinities with the Cimicomorpha, near the Reduviidae, and on the other hand with certain of the primitive Hydrocorisae.

The salivary glands of the Cryptostemmatidae, Henicocephalidae, Aepophilidae and various other small, but important, families are unfortunately unknown.

Summary

The structure of the salivary glands depends more on the taxonomic relationship of the species than on feeding habits or on the nature of the secretions and the use of salivary gland structure in higher classification is proposed. Accessory glands are diagnostic for each of the basic divisions of terrestrial Heteroptera, the Pentatomomorpha possessing tubular and the Cimicomorpha vesicular accessory glands. Some suggested characteristics of the salivary glands of most superfamilies and families in the Geocorisae are given.

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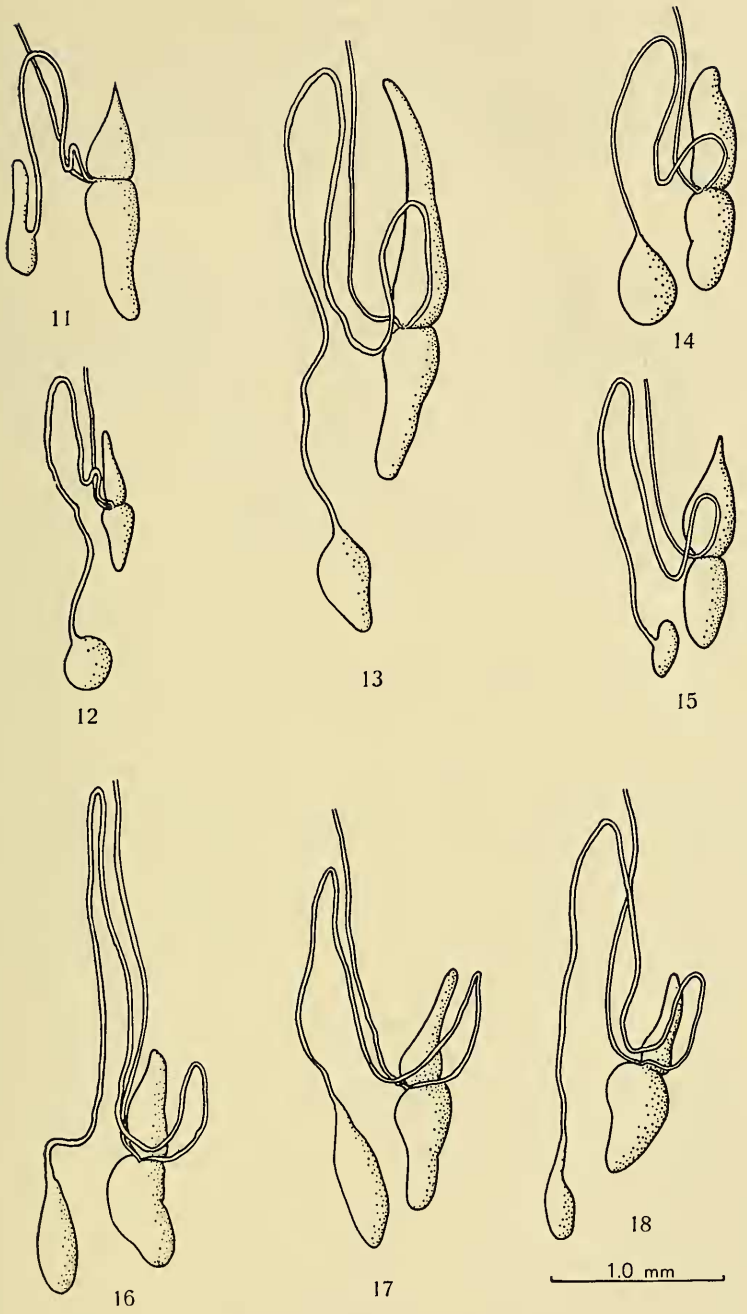

Figs. 11—18. Salivary glands of Miridae. 11. *Bryocoris pteridis* Fall. (Bryocorinae). 12. *Monalocoris filicis* L. (Bryocorinae). 13. *Phytocoris longipennis* Flor (Mirinae). 14. *Plagiognathus arbustorum* Fab. (Phylinae). 15. *Blepharidopterus angulatus* Fall. (Orthotylinae). 16. *Stenodema laevigatum* L. (Mirinae). 17. *S. laevigatum,* 5th instar larva (Mirinae). 18. *S. calcaratum* Fall. (Mirinae).

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